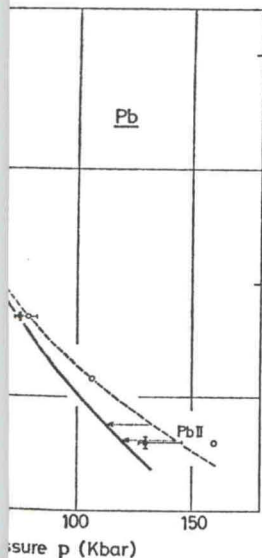


carbide, the lateral tightness coming from a sapphire ring. Obviously the pressures are not ideally homogeneous nor hydrostatic. The main advantage of this type of cell is the high pressure range, whereas the piston-cylinder arrangement is limited to pressures between 50 and 60 kbar.

**and Procedures**

From a crystal bar of purity better than 99.999% rolled at room temperature to 20 μm diameter, measurements on zone refined material (Research Corporation) have been made.

The samples were monitored by carbon resistors, the pressure cell as possible. The transitions to the superconducting state were measured.



into account a recent correction of the high pressure cell, believed to represent a final recalibration of the cell, to show the trend of calibration change.

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The determination of pressure has been described earlier<sup>11</sup>: a lead sample serves as an internal manometer. The transition temperature of the lead sample defines the pressure, whereas the width of the transition indicates the inhomogeneity of pressure. The accepted pressure scale of phase transitions, which had been used in the calibration of the lead manometer<sup>11</sup>, has been revised recently<sup>12</sup>. This gives rise to a shift of the  $T_c(p)$  curve of Pb as shown in Fig. 2. The shift is not significant at pressures below 50 kbar. Our experimental points at higher pressures, however, have been derived from the revised  $T_c(p)$  curve.

With the exception of the cold work experiments, pressures have always been varied at room temperature. It is known that, depending on the purity of the material, up to 70% of the change in residual resistance produced by cold work may disappear in an annealing period of 5 min at room temperature<sup>13</sup>. Hence we waited about 24 h before cooling down. This period is supposed to be sufficient for the annealing of lattice defects which had been produced during pressurizing.

**Results and Discussion**

The discussion of the results, collected in Fig. 3, will be divided into two parts, corresponding to the phase diagram of zirconium. At normal pressure, Zr is hexagonal (hcp). The transition temperatures of this  $\alpha$  phase are less than 1.2 K over the entire pressure range of its stability. Between 50 and 60 kbar at room temperature, Zr undergoes a phase transition to the  $\omega$  phase, the properties of which will be discussed in greater detail below.

**$\alpha$ -Zirconium**

$T_c$  depends linearly on  $p$  in the whole pressure region investigated. There is, however, a distinct influence of sample history. Samples measured immediately after preparation ( $T_c(0)=0.66$  K) show a reversible pressure dependence of  $T_c$  up to approximately 40 kbar with  $dT_c/dp=5.4 \times 10^{-6}$  K/bar (dotted line), and a residual resistance ratio  $\Gamma=R(300\text{ K})/R(4.2\text{ K})=17$ . As soon as the pressure exceeded about 40 kbar,  $\Gamma$  increased to 25 and  $T_c$  was markedly lowered. After the pressure had been removed,  $\Gamma$  remained above 20. Moreover a new  $T_c(0)$  is observed, lower by 0.02 K than the original value. In a second compression cycle a slope  $dT_c/dp=3.5 \times 10^{-6}$  K/bar is measured. The enlarged residual resistance ratio increases again slightly near 40 kbar, but  $T_c(0)$  and  $dT_c/dp$  are unaffected by further cycling.

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